The International Space Station:

Its Research Benefits to the Aging Population

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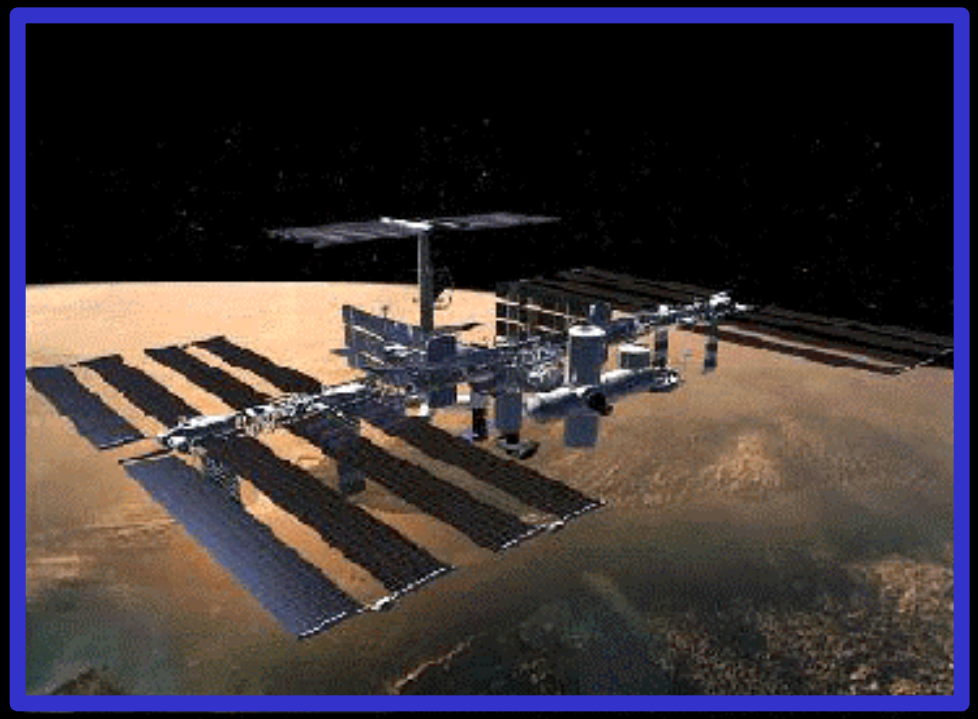
The International Space Station

- The largest and most complex international scientific project in history
- Will measure 356 ft by 290 ft., more than four times larger than Russian Mir
- Involves partnerships between U.S. and 15 other nations



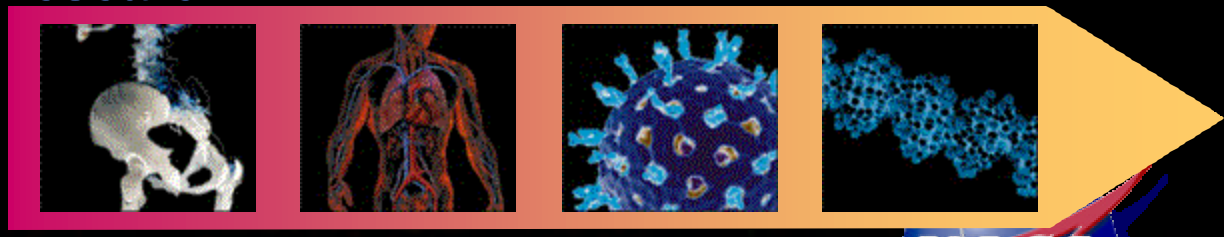
ISS Roles

- An advanced testbed for technology and human exploration
- A world-class research facility
- A commercial platform for space research and development

ISS Research Agenda

Research is being planned in various fields:

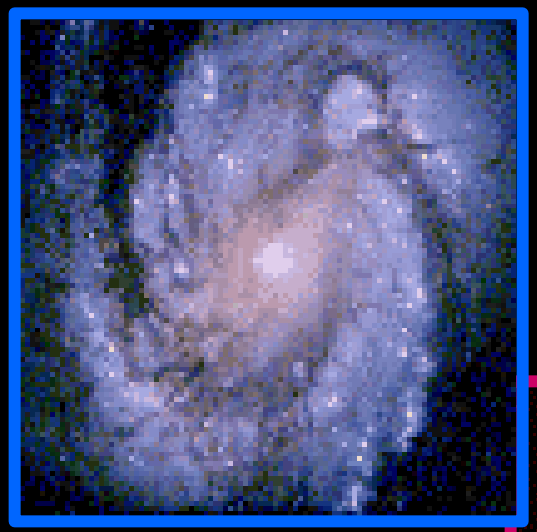
- **Space science and astronomy**
- **Earth sciences**
- **Gravitational biology and ecology**
- **Combustion science**
- **Materials science**
- **Biotechnology**
- **Biomedical research**



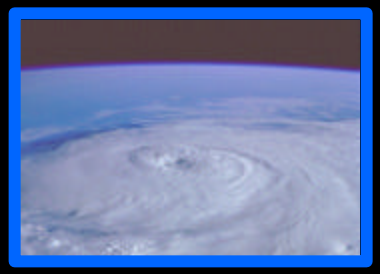
Increasing Fundamental Knowledge

Space Science and Astronomy

- These fields seek to gain a deeper understanding of the nature of space and the universe.
- This involves studies as specific as sampling the space environment for subatomic particles to observing galaxies and nebulae thousands of light years away.



Increasing Fundamental Knowledge



Earth Sciences

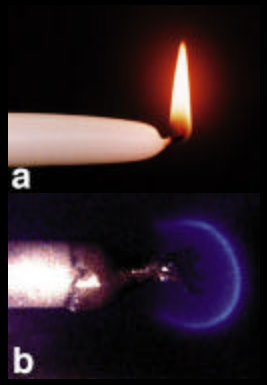
- The study of large-scale, long-term changes of the Earth with views not available from the ground
- Applications: detection of storm masses, monitoring and planning of crops

Gravitational Biology and Ecology

- Understanding the role of gravity in life on Earth by studying how plants and animals develop in its absence in space
  - Fundamental biology
  - Cell biology
  - Microbiology
- Applications: fitness countermeasures, air quality management, environmental engineering, food production

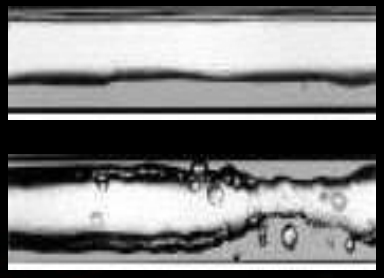
Improving Industrial Processes

Combustion Science



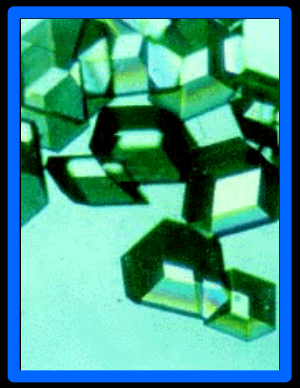
- The study of how materials combust, or burn, in space
- improve our understanding of air pollution, spacecraft and aircraft propulsion, materials processing, hazardous waste incineration, global environment heating
- applications: more efficient heaters for home, better fuel for our cars, broader range of synthetic materials

Materials Science

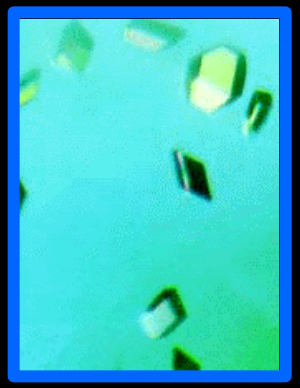


- The study of how materials form and how the forming process controls a material's properties
- design of new alloys, ceramics, glasses, semiconductors and polymers
- applications: contact lenses, better medical instruments, more efficient car engines

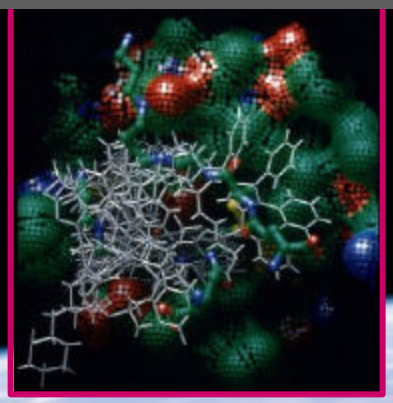
Biotechnology -
Protein Crystal Growth



Microgravity environment allows protein crystals to form precise and regularly shaped crystals (left) superior to smaller, irregularly shaped crystals grown on the ground (right).



drugs carefully designed at the molecular level



greater effectiveness with drugs and treatment of HIV, cancer, diabetes, emphysema and immune system disorders

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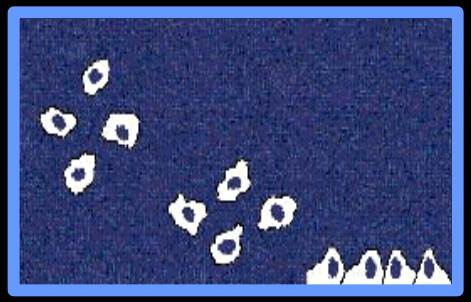
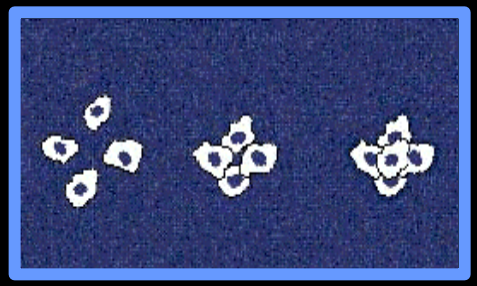
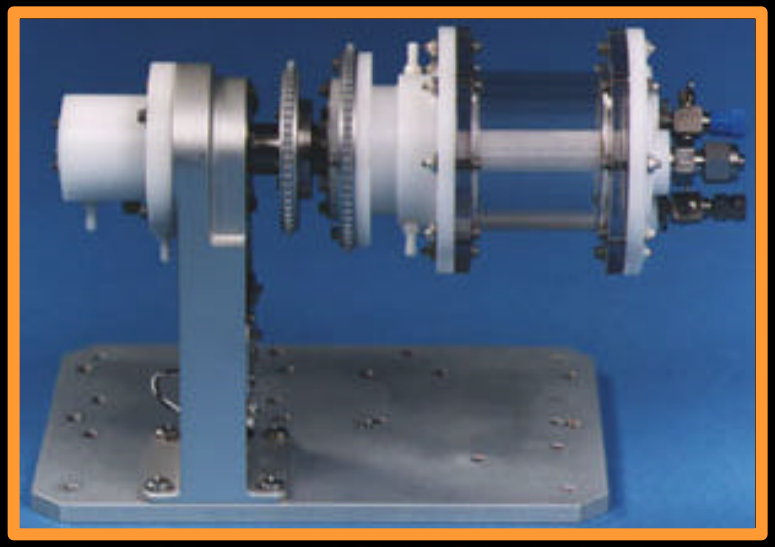
Biotechnology -
Cell and Tissue Culturing



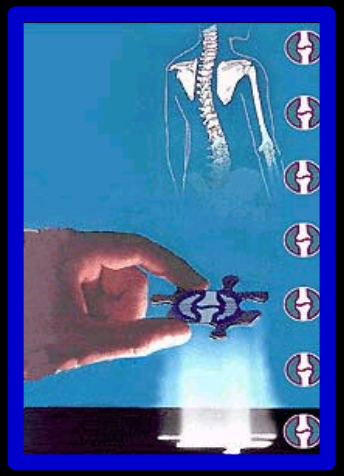
Cells grown in cultures on Earth (left) do not develop the complex 3-D organization that cells cultured in space acquire (right).





The bioreactor allows cells to form a complex matrix of collagens, proteins, fibers, and other chemicals so cell interaction can be closely studied.

Bioreactor Applications



- Recent successes:
  - > Culturing ovarian cancer tumors for cancer research
  - > Culturing lymph tissue for AIDS research
  - > Growing cartilage tissue for transplantation studies

Replacement of damaged cells…

- Targeted research:
  - > Infectious diseases - Lyme, Ebola, HIV
  - > Cancer - prostate, breast, lung, ovary, colon
  - > Diabetes - pancreatic tissue
  - > Therapies - musculoskeletal disorders on Earth and in space
  - > Drug efficacy

Tissues?

Organs?

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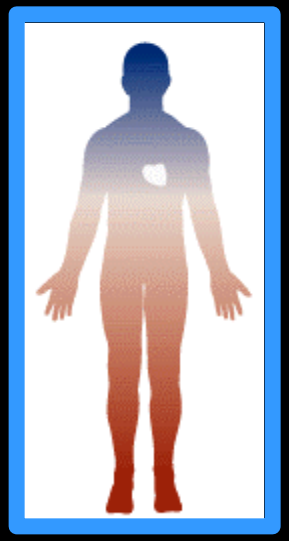
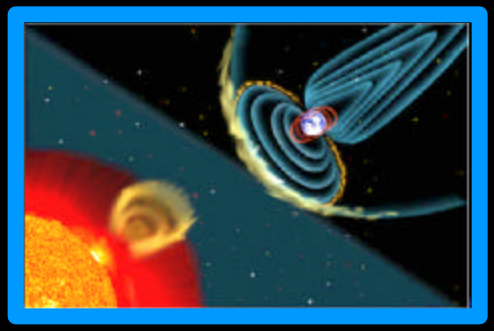
Biomedical Research Questions



How does the space environment affect human physiology, and what additional health risks will occur with space flight?

What are the long-term consequences of exposure to space radiation for humans?



How does microgravity and the space environment affect human behavior and performance?

Is space flight a reversible model of the effects of aging on Earth?

Biomedical Research

In just the first three years of the International Space Station, research is already being planned for the following areas:

- Fitness – staying fit to face the challenges of space flight
- Avoiding lightheadedness – learning how to keep the cardiovascular system healthy
- Loss of balance and stability – avoiding falls which may result in fractures
- Immunology – keeping the body's defenses healthy
- Gastrointestinal function – proper nutrition for the challenges of space flight and aging
- A healthy, hygienic environment – monitoring the Space Station environment to protect the health of the crew

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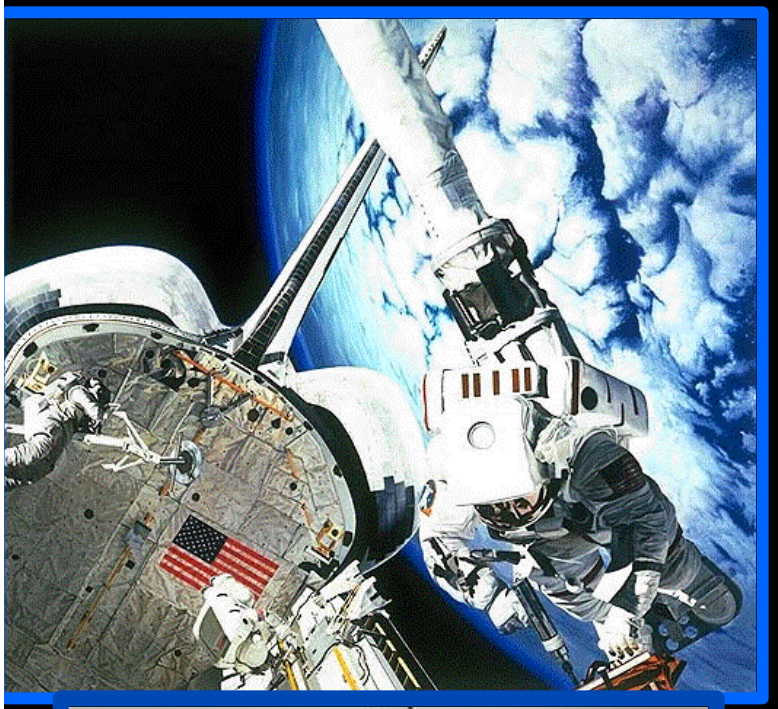

Studies in the design, engineering and habitability of the International Space Station will add data to the knowledge base of human performance in space, which will in turn provide information and technologies transferrable to Earth-based living.

Evaluation of a workstation layout using a 95th percentile human model

Future Capabilities

The better we understand the fundamental mechanisms of biological processes in space, the better we can improve the quality of life on Earth and ensure safe travel beyond low Earth orbit.